ALUMINIUM PRODUCTION INSTALLATION BY IGNEOUS ELECTROLYSIS

Domain of the invention

The invention relates to aluminium production plants based on igneous electrolysis using the Hall-Héroult process. It particularly relates to handling equipment used in the said plants.

State of the art

Aluminium metal is produced industrially by igneous electrolysis, namely by electrolysis of alumina in solution in a molten cryolithic bath called an electrolytic bath, using the well known Hall-Héroult process. The electrolytic bath is contained in pots comprising a steel shell lined on the inside with refractory and/or insulating materials, and a cathodic assembly located at the bottom of the pot. Anodes made of carbonaceous materials are partially immersed in the electrolytic bath. Each pot and its anodes form what is frequently called an electrolytic cell. The electrolysis current that circulates in the electrolytic bath and the layer of liquid aluminium through anodes and cathode elements, causes alumina reduction reactions to take place and also keeps the electrolytic bath at a temperature of the order of 950°C by the Joule effect.

The plants contain a large number of electrolytic cells arranged in line, in buildings called electrolysis halls or potrooms, and are electrically connected in series using connecting conductors so as to optimise the ground occupancy of the plants. The cells are usually arranged so as to form two or more parallel lines that are electrically connected together by end conductors. Thus, the electrolytic current passes in cascade from one cell to the next.

Work has to be done on electrolytic cells during operation of an electrolysis plant, particularly including the replacement of spent anodes by new anodes, tapping liquid metal from cells and tapping or adding electrolyte. The most modern plants are equipped with a lifting and handling unit (frequently referred to as a "overhead crane" or "travelling crane") that may be moved

longitudinally above and along the electrolytic cells, and is provided with several devices (frequently called "tools") such as shovels and hoists for handling and for working.

Although travelling cranes have many advantages when doing work on electrolytic cells, the applicant has noted that their multi-functional nature means that various facilities on them are underused, which unnecessarily increases operating costs.

Therefore, the applicant searched for means of reducing investment and operating costs of known installations.

Description of the invention

The purpose of the invention is an electrolysis installation designed for the production of aluminium by igneous electrolysis, comprising a potroom, a plurality of electrolytic cells arranged in line inside the potroom, a passageway (also called a "service aisle ") parallel to the said line of cells and located inside the potroom, and at least one first mobile lifting and handling unit called a "travelling crane", that is supported on a first runway parallel to the main axis of the line and that can be moved above the said line of cells on the said first runway.

The installation according to the invention is characterised in that it also comprises at least one second mobile lifting and handling unit called the "lateral portal crane" or "lateral gantry", and a second runway parallel to the main axis of the line and independent of the first runway, and in that this second unit is supported by the said second runway and can be moved underneath the first unit, along the said line of electrolytic cells on the said second runway, such that the two lifting and handling units can be moved independently, and in that the said second unit is capable of lifting and handling liquid metal ladles and/or liquid bath ladles.

In his search for a solution to the stated problem, the applicant had the idea of separating the handling and lifting devices (or "tools") as a function of the displacement requirements for each operation done on the cells. More precisely, the applicant had the idea of separating operations that require movements of the

said tools over a large proportion of the surface of the electrolytic potroom, such as anode changes, from operations limited to much more specific zones of the potroom, such as tapping liquid metals that only involves movements along a relatively narrow strip along one of the ends of the cells.

The applicant also had the idea of equipping the potroom with at least one second lifting and handling unit independent of the first unit and moving underneath the first unit, and making it specialised in operations that only require mobility along the ends of the cells. The two units can pass one above the other so that one can move independently of the other.

Another purpose of the invention is to use an electrolysis installation according to the invention for production of aluminium.

Another purpose of the invention is a production plant comprising at least one electrolysis installation according to the invention.

The invention will be better understood with the help of the figures and the detailed description given below.

Figure 1 illustrates an electrolysis installation for aluminium production according to prior art.

Figure 2 illustrates an electrolysis installation for the production of aluminium according to the invention.

Figure 3 illustrates a variant of the electrolysis installation for the production of aluminium according to the invention.

Figure 4 illustrates an embodiment of a lateral lifting and handling unit in an electrolysis installation for production of aluminium according to the invention.

Figure 5 illustrates typical displacement limits of the lateral lifting and handling unit according to the invention.

Figure 6 illustrates a lateral lifting and handling unit of an electrolysis installation for the production of aluminium according to the invention in a liquid metal tapping position.

The electrolysis plants intended for the production of aluminium comprise a liquid aluminium production zone that comprises one or several electrolytic

potrooms (1). These potrooms contain electrolytic cells (2) that are arranged in substantially linear rows or lines, each line typically containing more than a hundred cells. Each potroom typically contains one or two lines of electrolytic cells.

Passageways are also provided in the units for circulation, particularly for the transport of equipment, anodes and liquid aluminium. In particular, the electrolytic potrooms (1) are served by external peripheral roads and access means (4, 5) to enable motorised vehicles to enter and to leave (16).

Each potroom usually comprises at least one internal passageway (15) called the "service aisle" parallel to the line of cells. This aisle is used for the circulation of motorised vehicles (16) and operators (17) and for temporary storage of equipment (such as anodes) or apparatus. The service aisle (15) is usually elevated above the ground (3), so that access ramps (5) are necessary between the aisle and the peripheral roads.

As shown in figure 1, an electrolytic potroom (1) typically comprises a usually metallic structure (6), building cladding (7), and at least one lifting and handling unit (or "travelling crane") (8) to perform operations on the pots.

The travelling crane (8) comprises a cross beam or member (9) and at least one (and typically two) trolleys (10, 11) that can be moved along the cross beam. Each trolley (10, 11) is typically provided with lifting means (12) and/or tools (13) (such as a shovel). The travelling crane (8) is supported on and travels along a runway (14) that typically includes two running means (14a, 14b) such as rails parallel to each other and to the main axis A of the potroom (and the line of cells). The running means (14a, 14b) usually guide displacement of the travelling crane (8). The runway (14) is typically entirely elevated above the level of the service aisle (15). The corresponding running means (14a, 14b) are typically fixed to the structure (6) of the potroom. The travelling crane (8) can normally be moved from one end of the potroom to the other along the main axis A of the potroom. Combined displacements of the cross beam (9) along the potroom and the trolleys (10, 11) along the cross beam generally provide access to all electrolytic cells (2) and the service aisle (15).

The travelling crane (8) is typically capable of performing operations such as an anode change, filling feed hoppers with crushed bath and AlF_3 from electrolytic cells, and lifting and handling pot elements.

According to the invention, the electrolysis installation intended for aluminium production by igneous electrolysis, comprises a potroom (1), a plurality of electrolytic cells (2) arranged inside the potroom (1) so as to form at least one line with a main axis A, a so called « service » aisle (15) parallel to the said line of cells and located inside the potroom (1), and at least one first mobile lifting and handling unit (8) called a "travelling crane", supported on a first runway (14) parallel to the main axis A of the line, and that can be moved above the said line of cells on the said first runway, and is characterised in that it also comprises at least one second mobile lifting and handling unit (20) called the "lateral portal crane" and a second runway (21) parallel to the main axis A of the line and independent of the first runway (14), in that the said second unit (20) is supported on the said second runway (21) and can be moved along the said second runway (21) underneath the first unit (8) and along the said line of electrolytic cells (2), such that the two lifting and handling units can be moved independently, and in that the said second unit (20) can be used to lift and handle liquid metal ladles (also called "tapping ladles") and/or liquid bath ladles (also called "bath ladles").

The liquid metal ladles are used for tapping liquid metal from an electrolytic cell. Similarly, the liquid bath ladles are used to tap liquid electrolyte bath from an electrolytic cell. The lifting capacity of the lateral portal crane (20) is typically at least 10 tonnes, for lifting and handling full ladles.

Advantageously, the lateral portal crane (20), which is intended mainly for lifting and handling liquid metal ladles or liquid bath ladles, may possibly be capable of positioning the said ladles for tapping liquids from an electrolytic cell. Optionally, it may also be designed to lift and handle other elements and equipment placed in the service aisle (15).

Typically, the lateral portal crane (20) may be displaced (or "translated") from one end of the potroom (1) to the other. The total height H of the lateral

portal crane is typically less than the height Hm of the lowest part of the travelling crane (8), so that the travelling crane (8) and the lateral portal crane (20) can "pass" each other.

The lateral portal crane (20) comprises rolling means (22a, 22b) capable of travelling on the said second runway (21). The lateral portal crane (20) typically includes at least one transverse beam (23, 23a, 23b) that is preferably substantially horizontal and perpendicular to the main axis A.

The lateral portal crane (20) is equipped with a trolley (25) capable of being moved along a direction preferably substantially perpendicular to the main axis A of the line of cells. The trolley (25) typically moves along at least one transverse beam (23, 23a, 23b).

The working range of the lateral portal crane (20) is limited essentially to the area of the service aisle (15) and the service end (18) of the electrolytic cells (2). The travelling crane (8) can be used for lifting and handling operations that require access into the area above the electrolytic cells. Preferably, the movement range L of the trolley (25) is limited to a value equal to or less than the width Lo of the service aisle (15). The term "movement range" means the maximum extension of possible movements of the main axis B of the trolley in a direction transverse to the main axis A of the line of electrolytic cells. The said movement range is preferably such that the main vertical axis B of the trolley (25) is entirely above the service aisle, regardless of the position of the said trolley. In other words, the movement range L of the trolley (25) preferably extends not further than the outside edge (15a) of the service aisle on one side, and not further than the inside edge (15b) thereof on the other side.

Typically, the trolley (25) is equipped with lifting means (26) and gripping means (27). The gripping means (27) typically comprises one or several means (28) of fixing the object (such as an element or equipment) to be lifted and handled. The gripping means (27) can be installed on a pivoting support (29) to enable rotation of the element or equipment that it supports about an axis B.

In the case of a liquid metal ladle or liquid bath ladle (40), the attachment means (28) may be inserted in the corresponding attachment means (41) on the

said ladle (40). In this case, the attachment means (28) and (41) advantageously enable rotation of the ladle about an axis C typically parallel to the service aisle. The trolley may be equipped with a siphon (43) that is intended to be fixed on the ladle (40), and more precisely on the cover (44) of the ladle (40). This variant simplifies handling and transport of ladles (40).

The liquid metal tapping operation (frequently called the "pour operation") can be done using a process that typically comprises:

- deposition of a tapping ladle (40) facing a determined electrolytic cell (2);
- positioning of the lateral portal crane (20) facing the said cell;
- lowering the gripping means (27) (with the siphon 43) in a waiting position (a));
- stowing the ladle on the gripping means (27);
- fixing the siphon (43) on the ladle (40);
- lifting the ladle (40) to a first high position;
- rotating the ladle so as to orient the siphon (43) towards a determined electrolytic cell (2) (tapping position (b));
- displacement of the trolley (25) towards the said cell, so as to bring the ladle towards the said cell;
- lowering the ladle to a second high position and possibly rotating the ladle (or "tipping" it) around the C axis, so as to bring the tip of the siphon into the cell;
- tapping the metal.

Elements of cells and equipment such as anodes or liquid metal ladles that will be lifted and transported by the travelling crane (8) or the lateral portal crane (20) may be transported on pallets (42) and stored in the service aisle (15).

Advantageously, the electrolytic cells (2) are fully or partly surrounded by working floors (50). Typically, operators can access these working floors by fixed or movable staircases.

In one advantageous embodiment of the invention, the service aisle (15) is located on a first level, which is preferably located at the level of the ground (3)

outside the potroom (1), and the working floors (50) are located at at least one second elevated level at a determined height Hb above the first level. The height Hb is typically between 0.5 m and 4 m. This configuration simplifies the civil works of the building and makes it more economic.

In this variant of the invention, the working floors (50) may possibly comprise a service balcony (51) on the side of the service aisle (15), and the said balcony may possibly be common to all cells (2). The service balcony (51) preferably comprises a handrail (52) for safety reasons.

When the working floors (50) comprise a service balcony (51) (with width Bo), the movement range L of the trolley (25) may be such that the main axis B of the trolley (25) may also overhang or cantilever over the said balcony. In this case, the value of the movement range L may be larger than the width Lo of the service aisle (15), but will preferably remain less than the distance Do between the outside edge (15a) of the service aisle and the inside edge (51a) of the balcony, such that it overhangs only the service aisle (15) and the service balcony (51), regardless of the position of the said trolley. In other words, the movement range L of the trolley (25) preferably extends not further than the outside edge (15a) of the service aisle on one side, and not further than the inside edge (51a) of the service balcony on the other side.

The working floors (50) preferably include floors (53) between the cells. When the working floors (50) comprise a service balcony (51), the latter is preferably at the same level as the said floors (53) between the cells.

In one preferred embodiment of the invention, the second runway (21) comprises a first running means (21a) elevated above the level of the service aisle (15) and a second running means (21b) at a lower level than the first running means (21a). The second running means (21b) is preferably close to or on the service aisle (15). In particular, the second running means (21b) may be located directly on the service aisle (15) as illustrated in figure 2, or it may be located on a platform (19) with a determined height Ha above the said aisle, as illustrated in figure 3. The height Ha is typically between 0.2 and 2.5 m. The second running means (21b) is advantageously also directly on the service aisle (15), thus

covering a determined circulation strip which considerably simplifies the installation. In these variants, the rolling means (22a, 22b) typically comprise rolling means "on the ground" such as wheels or wheel sets (22b) supported on the second running means (21b) (either on the said platform or on the service aisle (15)). In these embodiments of the invention, the lateral portal crane is called the "semi portal crane" or "semi gantry" because only one part of the runway is elevated. The rolling means (22a) supported on the elevated running means (21a) is typically placed at one end of the transverse beam(s) (23, 23a, 23b). The rolling means on the ground (22b) may be fixed to the transverse beam(s) (23, 23a, 23b) by uprights (24).

The running means (21a) elevated above the level of the service aisle (15) is located at a determined height which is typically more than 3 m in order to leave sufficient space for the passage of vehicles (16) and the storage of pot elements or equipment in the service aisle (15). The elevated running means (21a) is advantageously fixed to the structure (6) of the potroom (1), which stabilises the lateral position of the lateral portal crane (20) and thus enables automatic operation of the lateral portal crane without the need for guide systems that could be sensitive to magnetic fields.

The second running means (21b) is advantageously at a distance of less than 0.5 m from the inside edge (15b) of the service aisle (in other words the edge of the aisle located at the side of the line of the cells), or possibly adjacent to the said edge (15b), to avoid taking up space in the service aisle (15).

When the working floors (50) comprise a service balcony (51) on the same side of the service aisle (15), the second running means (21b) may be on the service balcony (51), or it may be located on a platform fixed to the service balcony.

The potroom (1) may comprise two or several lines of parallel cells. In this case, it may be advantageous to provide one travelling crane for each line of cells or each group of lines of cells, and at least one lateral portal crane for each line of cells.

List of numeric marks

1	Electrolytic potroom
2	Electrolytic cell
3	Ground
4	Access means
5	Access ramp
6	Structure
7	Building cladding
8	Travelling crane
9	Cross beam
10	First lifting and handling trolley
11	Second lifting and handling trolley
12	Lifting means
13	Tool
14	Travelling crane runway
14a, 14b	Travelling crane running means
15	Service aisle
15a	Outside edge of service aisle
15b	Inside edge of service aisle
16	Motor driven vehicle
17	Operator
18	Cell service end
19	Running platform
20	Lateral portal crane
21	Lateral portal crane runway
21a, 21b	Lateral portal crane running means
22a, 22b	Rolling means
23, 23a, 23b	Transverse beam
24	Upright
25	Trolley
26, 26'	Lifting means

27	Gripping means
28	Attachment means
29	Pivot support
30	Parallel beam
40	Liquid metal ladle or liquid bath ladle
41	Attachment means to a ladle
42	Pallet
43	Siphon
44	Cover
50	Working floor
51	Service balcony
51a	Inside edge of service balcony
52	Handrail
53	Working floor between electrolytic cells